

Harpacticus furcatus LANG from the Antarctic Peninsula,
with Reference to the Copepodid Stages
(Copepoda: Harpacticoida)

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南極半島から発見された *Harpacticus furcatus* LANG と
そのコペポダイト期幼生について

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要旨: *Harpacticus furcatus* LANG が南極半島西岸にあるアルミランテ・ブラウン基地付近の潮溜りで得られた標本に基づいて再記載された。原記載では雌の第2胸肢内葉第2節に1刺毛のみがあることになっていたが、この標本ではすべて2刺毛を有し、原記載とは明らかに違っていた。しかし、残っていた原著者の標本9個体を再検討したところ、すべて2刺毛を有し、この重要な分類形質において今回報告したものと完全に一致した。すべてのコペポダイト期幼生の形態も記載され図で示されているが、その結果、本種は第2～第4胸肢内葉の外刺棘の形成様式が non-retarded formation 型であることが明らかになった。

Abstract: *Harpacticus furcatus* LANG is redescribed, based upon some specimens collected in a tide pool near Almirante Brown Station on the west coast of the Antarctic Peninsula. Although the original description by LANG states that the female has only one inner seta on the middle endopodite segment of leg 2, all the females of the present material examined have two setae, and markedly differ from the LANG's description in this respect. All the nine female specimens of the remaining LANG's material, however, have two inner setae on the endopodite segment in question, and completely agree with those of the present material in this important taxonomic character. All the copepodid stages are also described and illustrated. As a result, it is clarified that this species is of the non-retarded formation type in the differentiation process of the endopodal outer spine of the leg 2, leg 3 and leg 4.

1. Introduction

During the stay at Almirante Brown Station in the Antarctic Peninsula as an exchange scientist of the Japanese Antarctic Research Program, the junior author found a rich population of a harpacticoid copepod in a small tide pool. The specimens

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collected were examined by the senior author, and they were identified with *Harpacticus furcatus* LANG (Family Harpacticidae) which was reported from South Georgia and Bransfield Strait by LANG (1936), though some remarkable discrepancies were detected between the present material and the LANG's description and figures. The material also contained a number of copepodids of various stages. They were safely identifiable with *H. furcatus*, because most of the adult females were ovigerous and they seemed to be in an active reproductive season and, further, no adult specimen of other *Harpacticus*-species was found in the material. The morphology of these copepodids is reported and compared with those of other related species.

2. Material Examined

All the specimens examined were selected from a sample collected by the junior author. Sampling data are as follows. Date; January 13, 1976. Locality; a tide pool of 40×70 cm in size and about 15 cm in depth near Almirante Brown Station (64°53'S, 62°53'W). Water temperature; 20.6°C measured at low tide in the daytime.

Harpacticus furcatus LANG

Harpacticus furcatus LANG, 1936, p. 8, figs. 3-10; LANG, 1948, p. 333, fig. 152.

Synonym. *Harpacticus chelifer* (O. F. MÜLLER): GIESBRECHT, 1902, p. 35, pl. VIII, figs. 1-12.

3. Description of Adults

The following description of adults is mostly based on a pair of specimens (the registered number ANT-3 for the female and ANT-9 for the male). The other specimens used for additional descriptions are indicated by each number in parentheses.

3.1. Female (Figs. 1~5)

Body (Figs. 1-1, 2), rostrum and furcal setae excluded, about 1.32 mm long, approximately 3.5 times as long as greatest width, and tintured with yellowish brown. Rostrum (Fig. 1-4) clearly defined at base, somewhat longer than wide, furnished with two pairs of sensillae. Cephalothoracic somite almost as long as four succeeding somites combined. Fourth free thoracic somite (Fig. 1-3) ornamented with an oblique row of some scattering spinules on lateral side and another row of spinules along posterior edge of lateral side. Genital double-somite (Figs. 1-3, 2-1, 3-1) without any trace of subdivision dorsally, but subdivided ventrally and laterally by a chitinous suture; anterior subdivision furnished with three oblique spinular rows on each dorso-lateral side; genital area (Fig. 2-1) ornamented with a pair of three close setulae representing rudimental leg 6. Posterior subdivision of genital double-somite and ante-

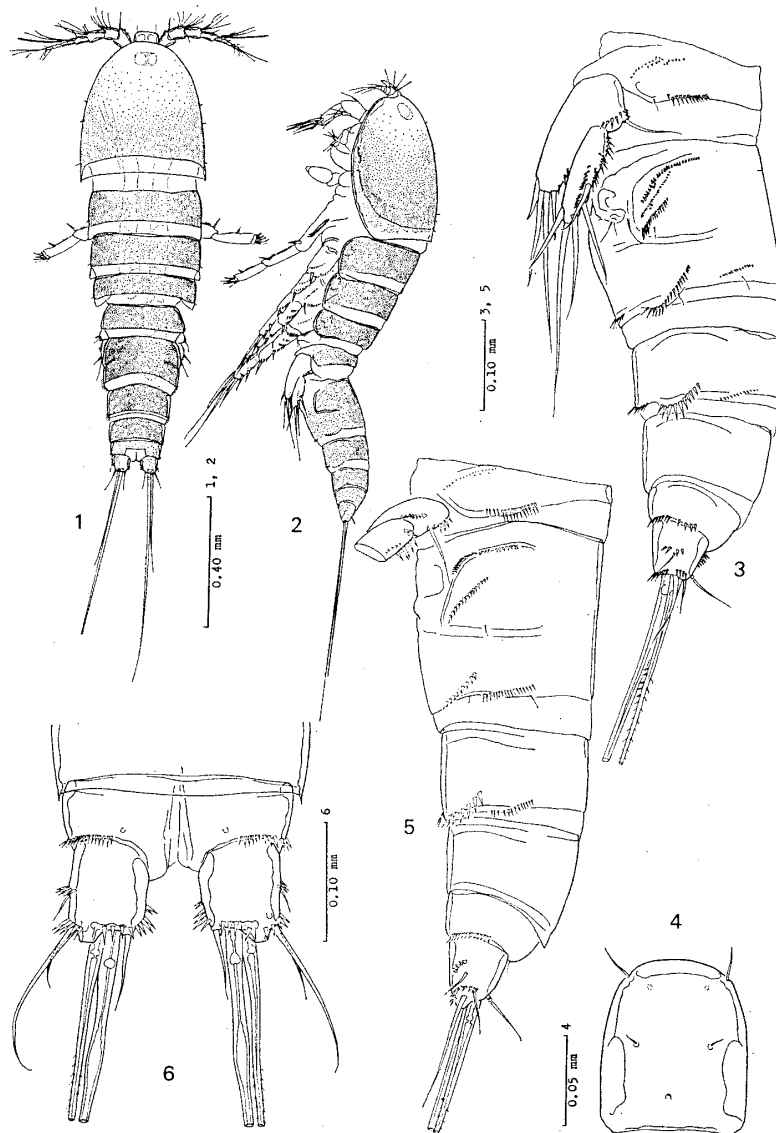


Fig. 1. *Harpacticus furcatus*. Female (1-4; ANT-3). 1. Habitus, dorsal. 2. Ditto, lateral. 3. Leg 5 and abdomen, lateral. 4. Rostrum. 5. Leg 5 and abdomen, lateral (ANT-8). 6. Anal somite with furcal rami, ventral (ANT-8).

penultimate somite furnished with a conspicuous transverse row of a number of spinules near posterior end of ventral side, and with two oblique spinular rows near posterior end of each lateral side. Penultimate somite without spinules. Posterior end of anal somite furnished with some spinules both laterally and ventrally. Furcal ramus a little longer than wide; a fine setula arising from midway of outer side, accompanied by a few spinules around base; two bare setae arising from lateral side near posterior end; a relatively short seta on inner posterior corner; principal terminal setae well-developed, accompanied by a few spinules near ventral side of their base; a basally geniculate seta arising from dorsal side near posterior end; some spinules on posterior half of inner side.

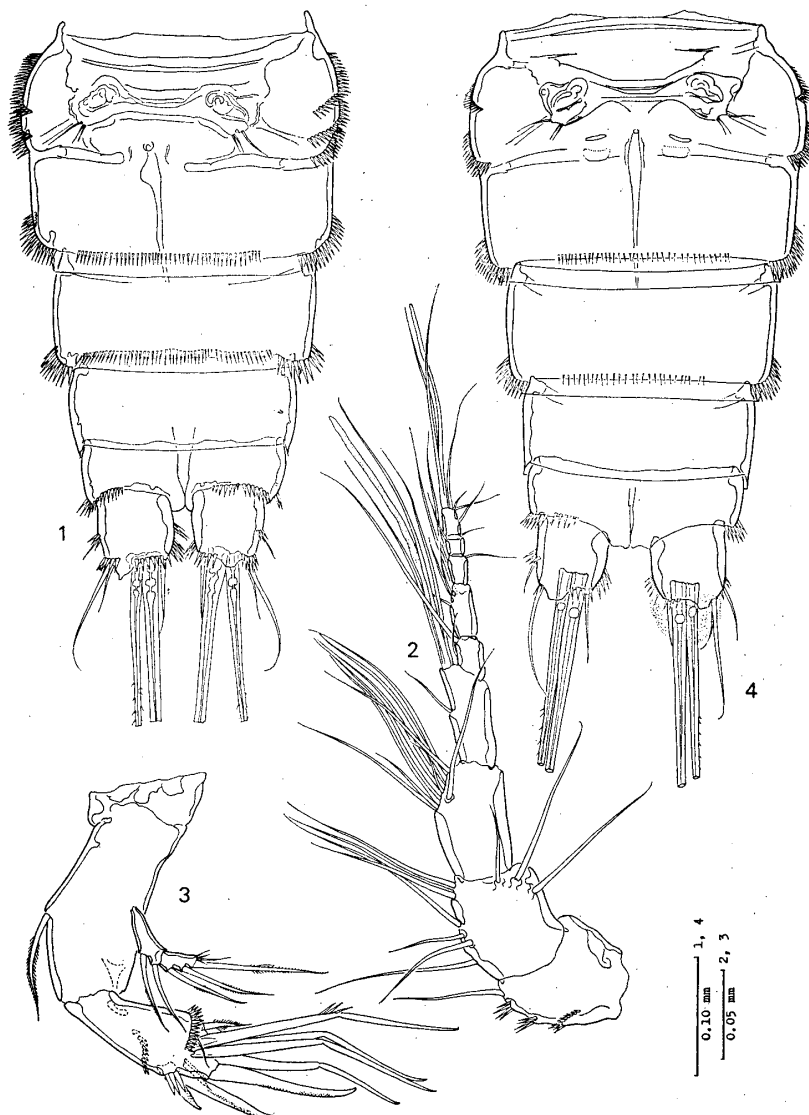


Fig. 2. *Harpacticus furcatus*. Female (1-3; ANT-3). 1. Abdomen, ventral. 2. Antennule. 3. Antenna. 4. Abdomen, ventral (LANG's specimen of Bransfield Strait).

Antennule (Fig. 2-2) nine-segmented; first three segments subequal in length and gradually tapering distally; first one furnished with a seta and three rows of some spinules on anterior side; fourth one narrower than preceding one, terminating in a long aesthetasc which is about three times as long as this segment; sixth one longest in distal five segments, almost as long as succeeding two segments combined. *Antenna* (Fig. 2-3). Coxa short and unornamented. Allobasis about twice as long as greatest diameter, with no spinule on anterior side; a spinulose seta arising from a point three-fifths the length of anterior side. Endopodite segment somewhat shorter than allobasis, ornamented with an oblique row of some spinules on inner side; a transverse row of

some close spinules on posterior half near distal end; four geniculate spines on distal end; one short, but thick, spinulose seta and a hair-like setula arising from postero-distal corner; three strong claws, which are somewhat serrate, on distal end and sub-distal edge of anterior side; two close spines arising from inner side near antero-distal corner. *Mandible* (see Fig. 3-6). *Praecoxa* with tridentate pars incisiva, tridentate (?) lacinia, three dentiform spines and a spinulose seta along cutting edge; pars molaris well-developed. *Coxa-basis* terminating in four bare setae, one of which directs outwards. *Exopodite* a little shorter than *endopodite*, two-segmented; first segment about three times as long as second, furnished with two setae, each on a subproximal

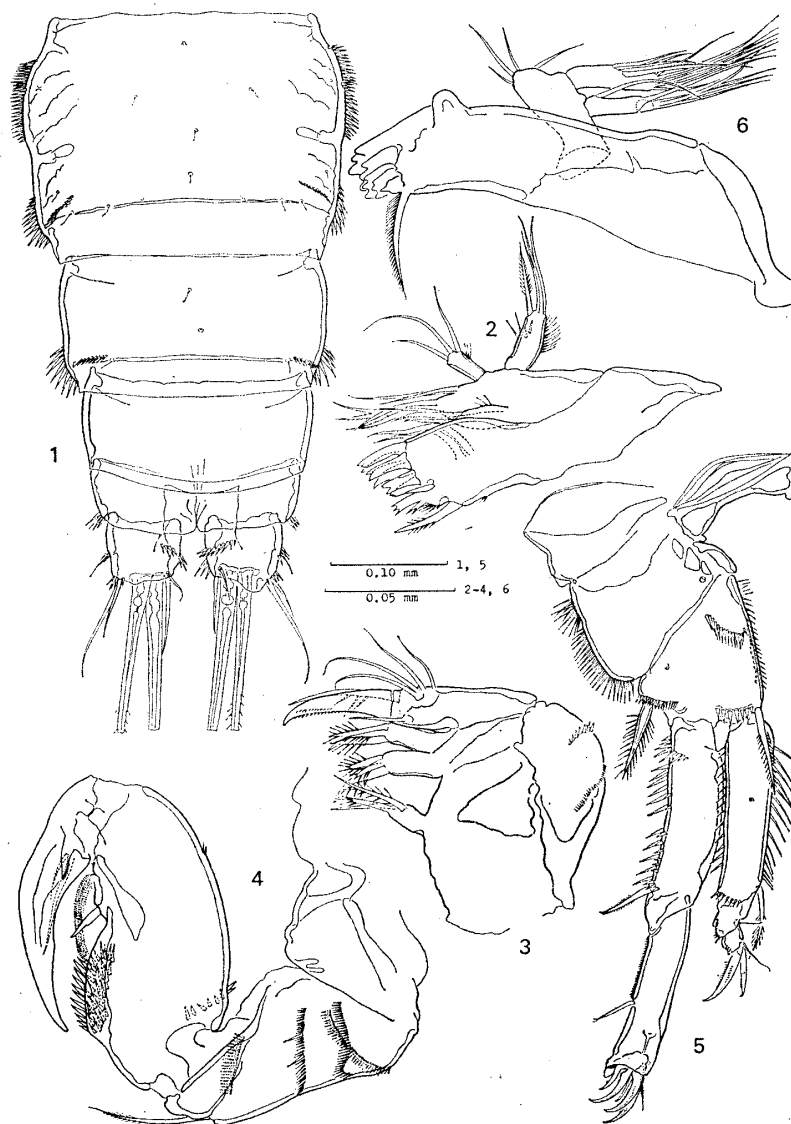


Fig. 3. *Harpacticus furcatus*. Female (1-5; ANT-3). 1. Abdomen, dorsal. 2. Maxilla. 3. Maxilla. 4. Maxillipede. 5. Leg 1. 6. Mandible (ANT-4).

portion and distal corner of inner (ventral) side; second segment terminating in four juxtaposed setae. Endopodite represented by a cylindrical segment furnished with three (two ?) bare setae and one somewhat hairy seta on and near midway of inner edge, and terminating in a pair of three juxtaposed setae and two separate setae. *Maxillula* (Fig. 3-2). Arthrite of praecoxa furnished with eight (?) more or less serrate claws and spines along inner edge, some spinules on dorsal corner, one spinulose stout seta on a subdistal ledge of dorsal side, and a few close spinules at midway of dorsal edge; a pair of parallel setae arising from posterior side. Distal end of coxal process reaching middle of arthrite of praecoxa, ornamented with three setae, at least one of which is spinulose. Inner process of basis with two close setae on ventral side, four setae, two of which are spinulose, on apical end. Exopodite represented by a segment, about 2.5 times as long as greatest width, fringed with some spinules on both edges, and furnished with one spinulose seta on subapical inner edge and three bare close setae terminally. Endopodite smaller than exopodite, with three bare setae apically and a few spinules on outer side. *Maxilla* (Fig. 3-3). Syncoxa ornamented with two oblique rows of some spinules on outer side and three endites, each furnished with three more or less spinulose setae apically or subapically. Basis with a strong claw which is spinulose along dorsal side, and one sharp spine with a few conspicuous spinules and a short seta. Endopodite represented by four bare setae. *Maxillipede* (Fig. 3-4). Coxa unornamented. Basis with four transverse or oblique rows of a number of spinules; one somewhat spinulose seta arising from a subdistal portion of inner edge. First endopodite segment robustly built, with a number of stout spinules on a sclerotized rim of proximal half of inner side; a short spine arising from a subdistal portion of inner edge; a transverse row of some spinules on a subproximal portion; a few spinules attaching on a point two-thirds the length of outer side. Second endopodite segment forming itself a strong claw accompanied by a short, somewhat spinulose spine on posterior side near base and two bare close setae on anterior side.

Leg 1 (Fig. 3-5). Coxal outer edge with a group of some spinules subproximally and fringed with a row of some narrow but seemingly rigid spinules (23 spinules in the right leg illustrated and 20 in the left one). Basis ornamented with an oblique row consisting of 14 spinules (15 in the other leg) on anterior side near inner proximal corner. Both rami three-segmented. Exopodite; outer seta of first segment densely spinulose along both sides; second segment forming itself a sclerotized protuberance on inner distal corner, fringed with a number of short spinules (28 in the leg illustrated and in the other one, too) along proximal half of outer margin, furnished with an outer spine, which is finely spinulose along outer side, and a narrow, somewhat hairy setula on inner side near distal end; third segment ornamented with four more or less spinulose claws and one narrow bare spine. Endopodite; a fine setula arising from inner distal corner

of second segment; third segment ornamented with one claw, of which outer side is spinulose in two rows, one geniculate spine and a narrow setula terminally. *Leg 2* (Fig. 4-1). An arched row of some stout spinules attached on not only anterior side but also posterior side near outer edge. Outer spine of basis thick and spinulose. Of third exopodite segment outer spines delicately spinulose on each outer edge. First endopodite segment about twice as long as wide. Second endopodite segment furnished with two inner setae. Of third endopodite segment, first inner seta somewhat rigid and finely spinulose along outer side, and both terminal setae spinulose outwards and hairy inwards. *Leg 3* (Fig. 4-2). Outer seta of basis entirely bare. Exopodite somewhat longer than that of leg 2; third segment with three inner setae. Endopodite; first segment about 1.5 times as long as wide; second one a little shorter than first; third one not exceeding middle of last exopodite segment, somewhat tapering apically, approximately three times as long as greatest width, with three inner setae; interspace between first two inner setae of last segment abnormally shorter than the next (normal situation is represented by Fig. 4-5). *Leg 4* (Fig. 4-3). Coxa a little smaller than in leg 3. Setal and spinal ornamentation of basis and exopodite as in leg 3. Last exopodite segment of left leg abnormally with only two inner setae (Fig. 4-4). Endop-

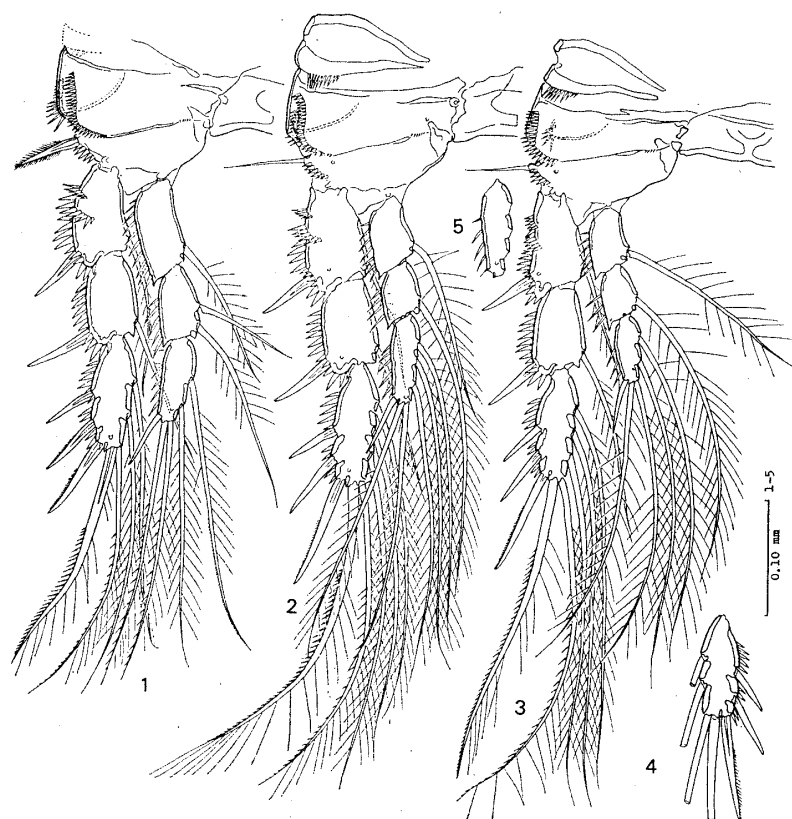


Fig. 4. *Harpacticus furcatus*. Female (ANT-3). 1. Leg 2. 2. Leg 3. 3. Leg 4. 4. Last exopodite segment of left leg 4. 5. Last endopodite segment of leg 3 (ANT-1).

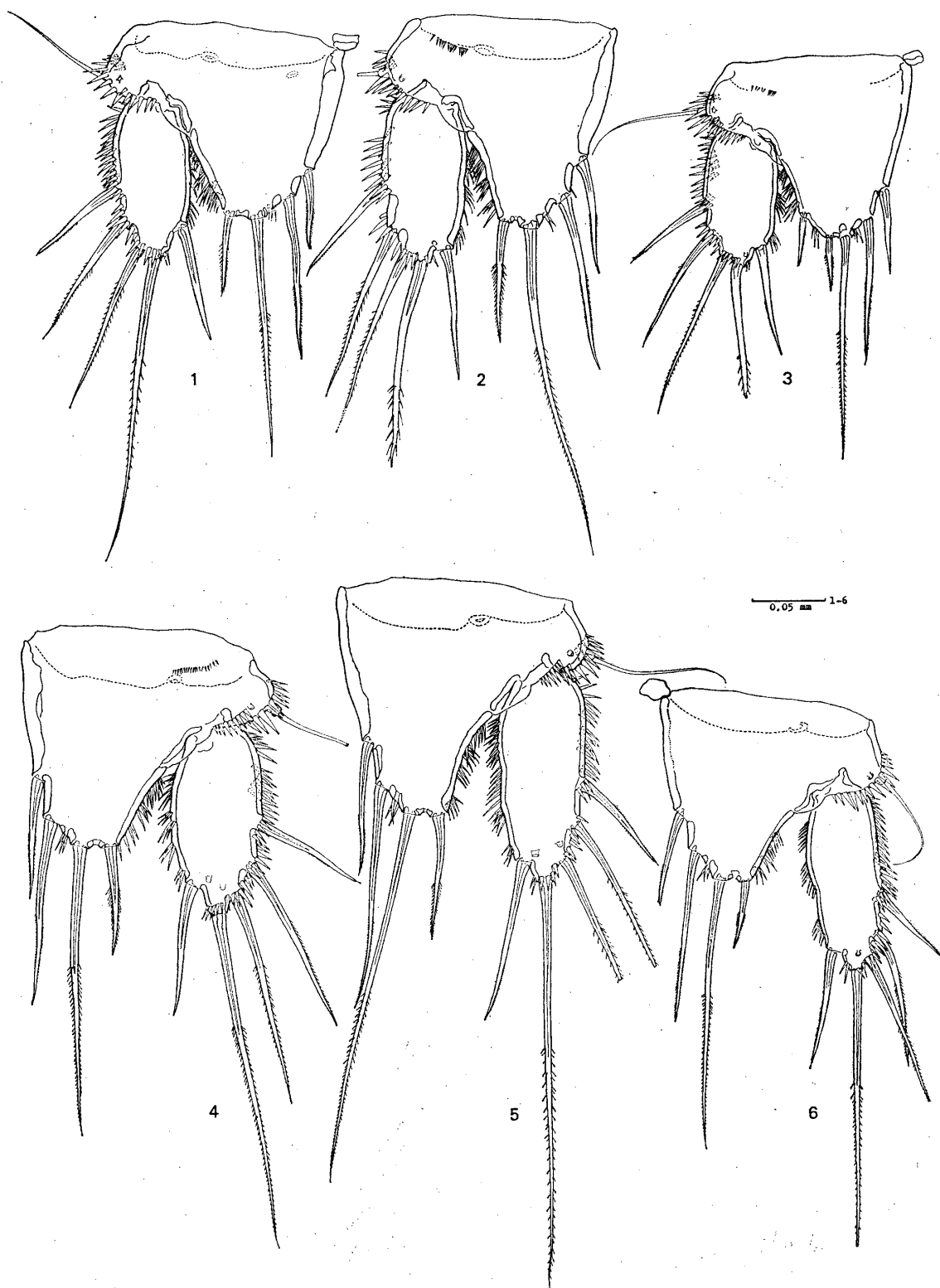


Fig. 5. *Harpacticus furcatus*. Female. Variation in leg 5. 1. ANT-3. 2. ANT-1. 3. ANT-24. 4. ANT-8. 5. ANT-6. 6. LANG's specimen of Bransfield Strait.

odite; all segments combined as long as first two exopodite segments combined; third one about 2.5 times as long as greatest width, with two inner setae. *Leg 5* (Fig. 5-1). Baseoendopodite furnished with four setae on inner expansion, in which first (inner) two are fairly rigid and delicately spinulose, and third one is much longer than the others; a few spinules arising from interspace between second seta and third one. A transverse row of some spinules attached on an outer subproximal portion of anterior side of baseoendopodite in left leg, though right leg illustrated is entirely lacking in such spinular row. Exopodite elongate ovoid in outline, about 2.3 times as long as greatest width, furnished with three outer setae, one terminal seta which is more than 1.5 times as long as this segment, and one spine arising from a ledge three-fourths the length of

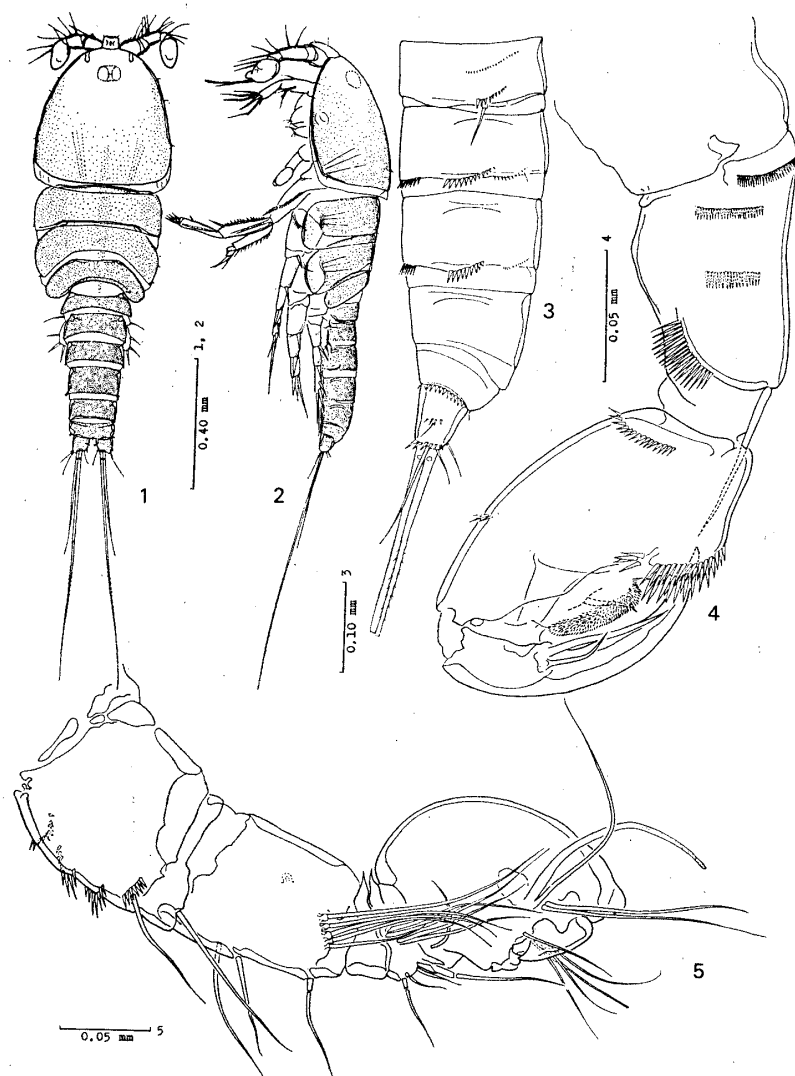


Fig. 6. *Harpacticus furcatus*. Male (ANT-9). 1. Habitus, dorsal. 2. Ditto, lateral. 3. Abdomen, lateral. 4. Maxillipede. 5. Antennule.

inner margin.

3. 2. Male (Figs. 6~9)

Body (Figs. 6-1, 2) about 1.3 mm long, somewhat depressed dorso-ventrally, tintured as in the female described. First abdominal somite with a pair of leg 6, each represented by a bare seta arising from a short cylindrical process accompanied by some spinules; a vertical row of a number of fine spinules on both lateral sides. Of succeeding second and third abdominal somites each ventral side near posterior end with a transverse row of two and four groups of spinules, respectively. Inner side of furcal

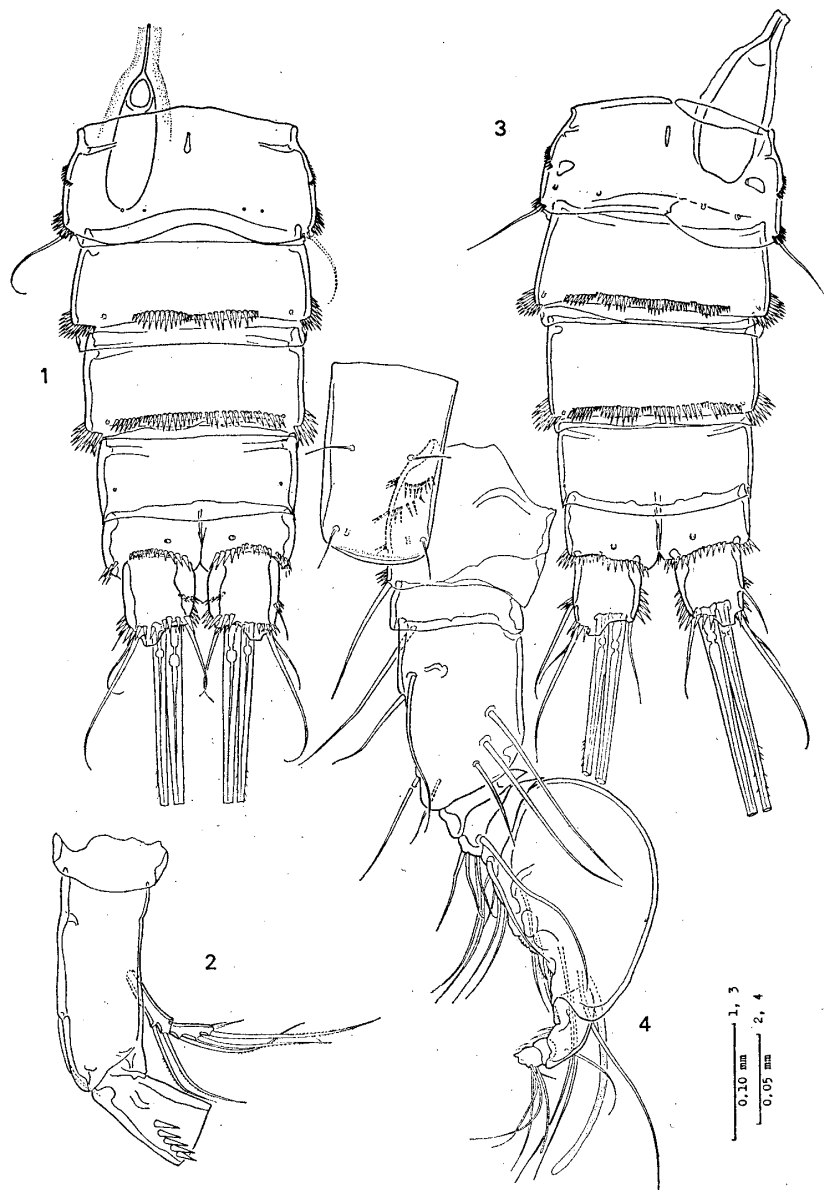


Fig. 7. *Harpacticus furcatus*. Male (1-2; ANT-9). 1. Abdomen, ventral. 2. Antenna. 3. Abdomen, ventral (ANT-5). 4. Rostrum and antennule (ANT-5).

ramus thickly sclerotized. *Antennule* (Fig. 6-5; see also Fig. 7-4) subchirocer; first segment thick, with four groups of spinules on anterior side; second one very short; a thick aesthetasc arising from ventral side of swollen segment; apical two segments small; a narrow aesthetasc, together with some setulae, arising from outer side of last segment. *Antenna* (Fig. 7-2) a little narrower than in female, and with no spinule on allobasis as in female. *Mandible*, *maxillula* and *maxilla* as in female. *Maxillipede* (Fig. 6-4) somewhat narrower than in female.

Leg 1. Oblique row of spinules on anterior side of basis undeveloped, and represented by a few very dwarfed spinules in right leg and entirely absent in left leg. Inner seta of basis reaching middle of first endopodite segment. Proximal half of outer edge of second exopodite segment furnished with 15 spinules in right leg and 20 in left. Other ornamentations almost as in female. *Leg 2* (Fig. 8-1). Coxa, basis and exopodite as described in female. Endopodite; outer edge of first segment fringed with

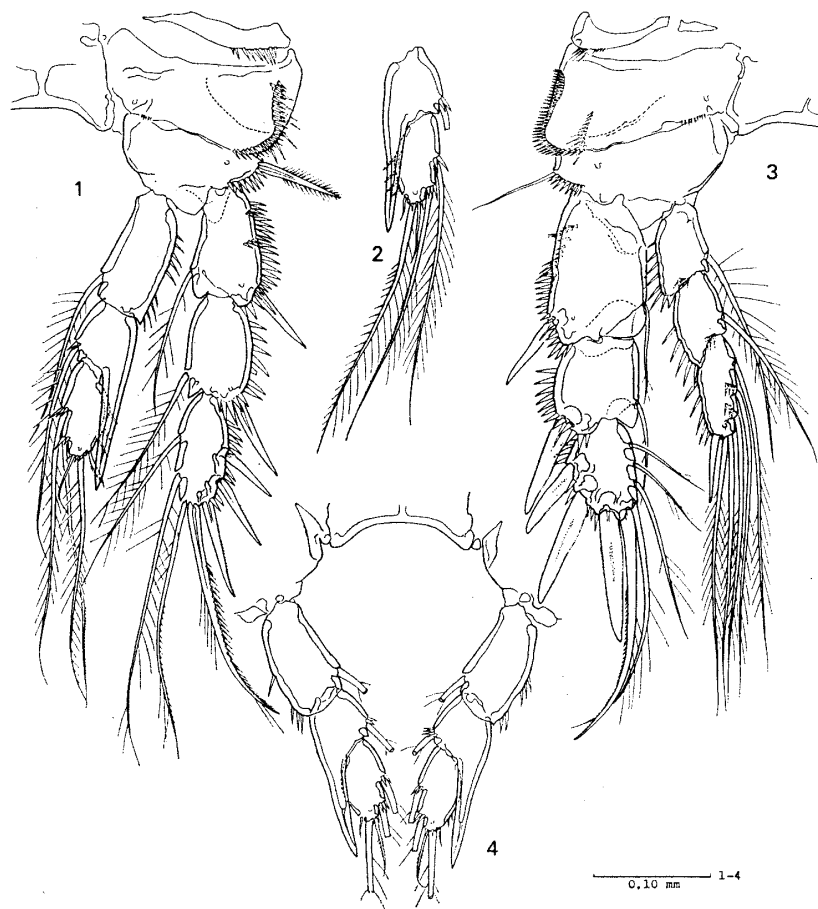


Fig. 8. *Harpacticus furcatus*. Male (1-3; ANT-9). 1. Leg 2. 2. Apical two endopodite segments of right leg 2. 3. Leg 3. 4. A pair of endopodites of leg 2 (ANT-23).

two groups of spinules which are separated from each other by a wide interval; second segment forming itself a mucroniform projection as in other congeneric species; third one fairly swelling outwards, furnished with three spinules along outer rim in left leg (four in right leg; Fig. 8-2), one hairy short seta on outer subdistal edge (a hair-like setula in right leg), two terminal setae, of which inner one is dwarfed, and two plumose inner setae, of which second one is delicately spinulose along its distal half. *Leg 3* (Fig. 8-3) robustly built. Exopodite transformed as in other congeneric species. A short row of a few spinules near each posterior end of first two endopodite segments. Third endopodite segment with several spinular rows posteriorly. *Leg 4* (Fig. 9-1). Endopodite segments ornamented with some spinules on each posterior side as shown in figure. Other ornamentations as in female. *Leg 5* (Fig. 9-2). A pair of baseoendopodites represented by a common plate. Exopodite approximately twice as long as greatest width, furnished with three spines along outer edge, one hairy terminal seta

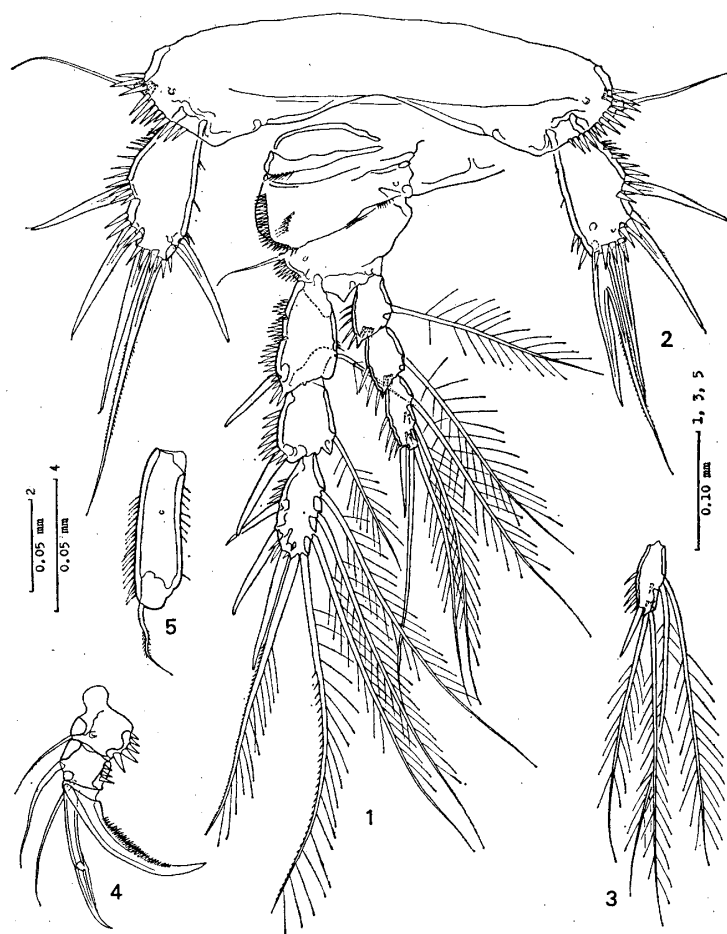


Fig. 9. *Harpacticus furcatus*. Male (1-2; ANT-9). 1. Leg 4. 2. A pair of leg 5. 3. Last endopodite segment of right leg 4 (ANT-23). 4. Apical two endopodite segments of leg 1 (ANT-16). 5. Aberrant endopodite of left leg 1 (ANT-17).

which is about twice as long as this segment, and one spine on inner edge near distal end. Ornamentation of left leg is apparently aberrant; terminal seta and inner spine basally fused to each other and forming a bifurcate appendix.

3. 3. Variability and abnormality

While nine females and 13 males, including a pair of the specimens described, were dissected and examined, a number of differences in various structures were found among them and even between a pair of certain legs in a single individual. Among these differences, some instances of which will be described below, the variability of the fifth pair of legs in the female is especially of a taxonomic importance.

Besides the fifth leg of the female described, other four instances are shown (Figs. 5-2, 3, 4 and 5). The shape of the inner expansion of baseoendopodite is fairly variable. A good example of an extremely prominent inner expansion is represented by a figure based on a specimen 1.45 mm long (Fig. 5-5; ANT-6). The length and situation of each seta of the inner expansion are also variable. A supernumerary seta is found in the right leg in a specimen (Fig. 5-3; ANT-24). The shape of exopodite segment varies between truncate oval (Fig. 5-3) and extremely stretched one (Fig. 5-5). Intermediate conditions would be represented by other figures (Figs. 5-1, 4). The transverse spinular row on the anterior side of baseoendopodite is not always present. This row is present in the both legs in some specimens (see Fig. 5-4 for an example; ANT-8), though such row is not detected in both the legs (see Fig. 5-6) or in either one of the legs.

On the other hand, body length ranged from 1.12 to 1.45 mm in the females and from 1.10 to 1.52 mm in the males. The body in several females and males is more depressed rather than in the couple illustrated. In most of females, there are only two spinular rows on each lateral side of anterior subdivision of genital double-somite (see Fig. 1-5). The length of furcal ramus is somewhat variable. An example of longer furcal rami is shown in the figure (Fig. 1-6; ANT-8) based on a female 1.30 mm long. The situation and size of the lateral seta of furcal rami are different among individuals (*cf.* Figs. 1-6, 2-1, 3-1, 7-1, 7-3) and even between the both rami of a single specimen (Fig. 7-3). About half of the males examined had four groups of spinules on the ventral side of their second abdominal somite (Fig. 7-3).

A male (ANT-16) had a supernumerary seta on the third exopodite segment of left leg 1 (Fig. 9-4), and his right leg possessed a few spinules on the corresponding portion instead of a seta. In a male (ANT-17), the endopodite of left leg 1 was lacking in the apical two segments (Fig. 9-5). The first endopodite segment of leg 1 has a pore which is usually on almost middle of its anterior side, but this pore is located more distally (about three-fourths the length) in the left leg of a male (ANT-20). The oblique spinular row on the anterior side of basis of leg 1 in the male is usually obscure, and entirely absent in a few cases.

In the leg 2 of the 13 males examined, the relative length of the mucroniform projection of the second endopodite segment is almost constant. Ornamentation of the last segment, on the other hand, is somewhat variable. The number of spinules attached on the outer rim varies between four and zero (see Fig. 8-4, based on ANT-23; no spinule on the right and two on the left). The outer seta of this segment is occasionally dwarfed into a hair-like setula, but is actually present in any cases.

In a male (ANT-23), the two inner setae of the last endopodite segment of the right leg 4 are closely located in the middle portion (Fig. 9-3), though the corresponding setae in the left leg are normally situated.

3. 4. Remarks

Setation of the second endopodite segment of leg 2 of females has so far been regarded as one of the most important taxonomic characters in the genus *Harpacticus*. In this connection, LANG's description of the setation of thoracic legs of *H. furcatus* must be corrected. He described that the setation of *H. furcatus* was the same as those of *H. littoralis* SARS in 1936, based upon the specimens collected from South Georgia and Bransfield Strait and, also the same as *H. chelifera* (O. F. MÜLLER) in 1948. Both *H. littoralis* and *H. chelifera* have only one inner seta on the second endopodite segment of leg 2. But *H. chelifera* sensu GIESBRECHT reported from Gerlache Strait, which was regarded as a synonym of *H. furcatus* by LANG (1936), had apparently two setae on the segment in question (GIESBRECHT, 1902). The senior author had doubts about these LANG's descriptions of 1936 and 1948, and tried to re-examine his material. Nine specimens among the 13 females collected in Bransfield Strait in 1903 (see LANG, 1936, p. 10) have fortunately remained at Naturhistoriska Riksmuseet, Stockholm. One of the specimens was dissected for a detailed study, and the other eight were examined without dissection. All these specimens have two inner setae on their second endopodite segment of leg 2, without any exception. The LANG's material, therefore, entirely accords with those of GIESBRECHT and the present material in this characteristic of the setation. On the other hand, since some other discrepancies were noticed between the LANG's description and figures and the LANG's specimen dissected, some comparative notes would be given below.

The exopodite of leg 5 (Fig. 5-6) in the specimen dissected is quite elongate, and strikingly resembles that of one of the present material (Fig. 5-5). The exopodite of leg 5 illustrated by LANG (1936, fig. 9) has a truncate appearance, and it rather approaches to those of some of the present material (see Figs. 5-2, 3). In the LANG's specimen dissected, body length of which is 1.25 mm, the genital double-somite and the antepenultimate somite have a transverse spinular row on each ventral side (Fig. 2-4), and furcal rami are not so elongate, almost as long as wide, though LANG described that the rami were 1.5 times as long as wide. The last mentioned difference would be

ascribable to the highly variable nature of this species.

3. 5. Discussion

The taxonomy within the genus *Harpacticus* is still very much confused by the presence of some inadequately described species and probably because of the high variability (see LANG, 1965, pp. 107–109). The present species is also such a case. The shape as well as the setal ornamentation of the leg 5 in the female is usually of particular importance for the harpacticoid taxonomy. In the present species, however, such characteristics in the leg 5 are so unstable that it is difficult to represent a typical form, and the taxonomic importance of the leg 5 is quite dubious. In the following, a comparison among some related species is made to facilitate identification of the present species without use of the shape and setal ornamentation of the leg 5, though no unique diagnostic character can be proposed.

Four important characters, which can be easily determined, are selected as follows; (1) antennule (♀) nine-segmented, (2) maxillipede with a ledged hand, (3) endopodite of leg 1 three-segmented and (4) second endopodite segment of leg 2 (♀) with two inner setae. The following five species are enumerated as the ones having all these four characters; *H. uniremis* KRÖYER, 1842, *H. arcticus* POPPE, 1884 (= *H. chelifera* var. *arcticus*), *H. septentrionalis* KLIE, 1939, *H. compressus* FROST, 1967, and the present species *H. furcatus* LANG, 1936.

Among them, *H. arcticus* and *H. septentrionalis* would be discernible from *H. furcatus* in a characteristic that some spinules are attached on the antennal allobasis (POPPE, 1884; ITO, 1976). *H. compressus* is markedly smaller than *H. furcatus* (0.721–0.802 mm in the female of *H. compressus*; FROST, 1967). Further, *H. uniremis* and *H. furcatus* are distinguished from each other by a difference in the ornamentation of leg 5 of the female. The baseoendopodite of leg 5 of *H. uniremis* has usually two close rows of some conspicuous spinules on the middle or the inner half of its anterior side (see ITO, 1971), though KLIE (1927, p. 6) reported that such a row was occasionally absent in his European material of *H. uniremis*. In *H. furcatus*, the corresponding row, whenever it is present, consists of very small spinules and is always localized on the outer half of the segment.

4. Description of Copepodid Stages

4. 1. First copepodid stage (sex unknown)

Body (Fig. 10–1) consisting of five somites, 0.38 mm long; pleurotergite differentiated on first thoracic somite; fourth somite (Fig. 11–5) unornamented, and last one furnished with transverse rows of some spinules ventrally. Principal terminal setae of furcal ramus basally confluent with each other. Antennule (Fig. 11–1) six-segmented;

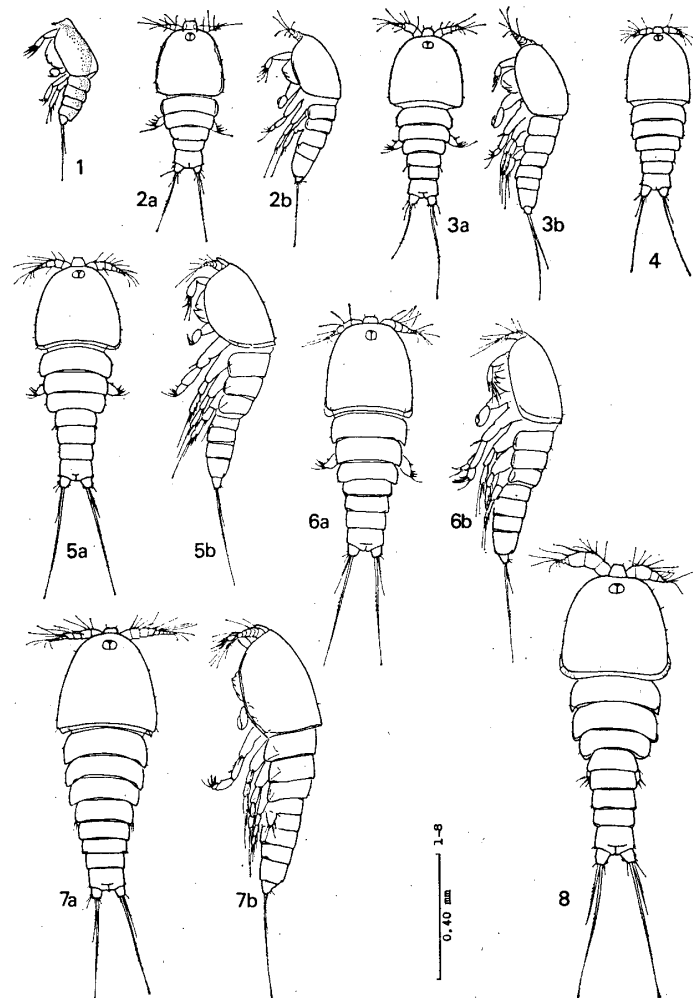


Fig. 10. *Harpacticus furcatus*. Copepodids. 1. First cop. 2. Second cop. 3. Third cop. female. 4. Third cop. male. 5. Fourth cop. female. 6. Fourth cop. male. 7. Fifth cop. female. 8. Fifth cop. male.

first segment with two short setae, one of which is spinulose (this spinulose seta is aborted in the illustrated one); second one with three setae, one of which is spinulose, and a narrow aesthetasc; third, fourth and fifth ones short; last one somewhat longer than thick, terminating in a very narrow aesthetasc together with some setae. *Antenna* (Fig. 11-2). Of second exopodite segment, apical seta somewhat thickened at base. Endopodite ornamented with three claws, three geniculate spines and two setulae.

Leg 1 (Fig. 11-3). Coxa and basis discernible from each other by an obscure suture. Basis without inner seta. Both rami one-segmented. Exopodite of an ovoid outline, with two short setae on outer edge, one claw on outer edge near distal end, and terminating in two claws and a spiniform seta. Endopodite a little shorter than exopodite, with a short spine on subapical outer edge, one elongate spine and one narrow seta on apical end, and two short setae on inner edge. *Leg 2* (Fig. 11-4). Coxa and basis

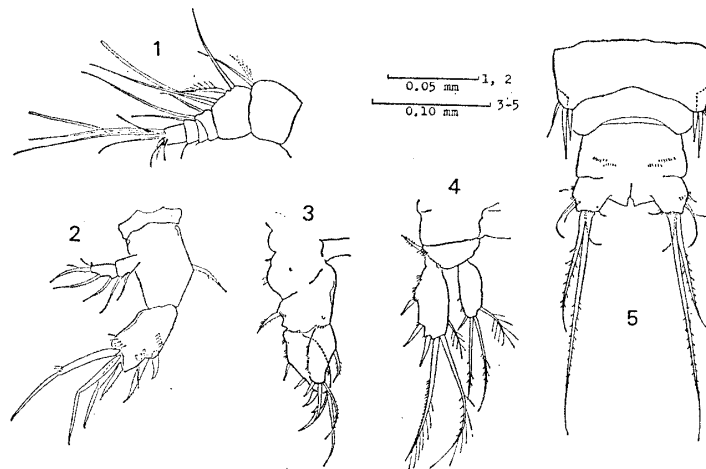


Fig. 11. *Harpacticus furcatus*. First copepodid stage. 1. Antennule. 2. Antenna. 3. Leg 1. 4. Leg 2. 5. Leg 3 and abdomen, ventral.

well demarcated from each other. Outer seta of basis sparsely spinulose. Both rami one-segmented. Exopodite with three outer spines, two terminal setae and one inner seta which is short and narrow and arises from a point three-fourths the length. Endopodite shorter than exopodite, with one short outer spine, two terminal setae and one inner seta. Leg 3 (Fig. 11-5) represented by a slight protuberance with two spiniform setae and one setula.

4. 2. Second copepodid stage (sex unknown)

Body (Figs. 10-2 a, b) consisting of six somites, 0.52 mm long; pleurotergite differentiated on first two free thoracic somites; fifth somite (Fig. 12-5) unornamented. Furcal ramus a little longer than wide; both principal terminal setae differentiated. Rostrum (Fig. 12-1) rectangular, with a pair of sensillae. Antennule (Fig. 12-1) seven-segmented, with no spinulose seta.

Leg 1 (Fig. 12-2). An inner seta and an oblique row of some spinules added onto basis. Both rami two-segmented. Exopodite; first segment about 1.2 times as long as second, with a short outer seta at a point two-thirds the length; second one furnished with one short seta and one claw on outer edge and terminating in two claws and one elongate spine. Endopodite; first segment about 2.5 times as long as second, with a transverse row of some minute spinules near distal end, and one inner seta; second one terminating in one claw, one geniculate spine and a very narrow setula. Leg 2 (Fig. 12-3). Coxa and basis as in preceding stage. Both rami two-segmented. First exopodite segment with no inner seta. Endopodite; first segment with one inner seta; second one about 1.3 times as long as first, with one outer spine, two terminal and two inner setae. Leg 3 (Fig. 12-4). Basis with a bare outer seta. Both rami one-segmented; setal and spinal ornamentation as in leg 2 in preceding stage. Leg 4

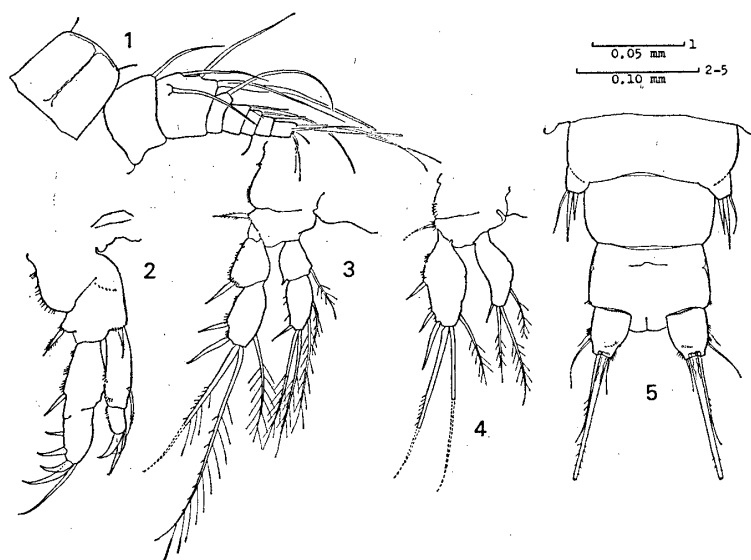


Fig. 12. *Harpacticus furcatus*. Second copepodid stage. 1. Rostrum and antennule. 2. Leg 1. 3. Leg 2. 4. Leg 3. 5. Leg 4 and abdomen, ventral.

(Fig. 12-5) represented by a protuberance with two spiniform setae and a bare outer seta, almost as in leg 3 in preceding stage.

4. 3. Third copepodid stage

Female. Body (Figs. 10-3 a, b) consisting of seven somites, 0.56 mm long; pleurotergite of first three free thoracic somites differentiated; sixth somite (Fig. 13-7) unornamented. *Antennule* (Fig. 13-1) seven-segmented; second segment relatively elongated, with a transverse suture on its posterior side (this suture seems to be a characteristic of female of this stage).

Leg 1 (Fig. 13-2). First exopodite segment elongated, about twice as long as second. Of first endopodite segment, inner margin fringed with some spinules and inner seta well-developed. *Leg 2* (Fig. 13-3). A vertical row of some conspicuous spinules added near outer margin of posterior side of coxa. Inner seta of first exopodite segment differentiated. One outer spine and one inner seta added onto second exopodite segment. Second endopodite segment somewhat elongated. *Leg 3* (Fig. 13-4). Both rami two-segmented. Exopodite; first segment without inner seta; second one furnished with two outer spines, two terminal and two inner setae. Endopodite; first segment with one inner seta; second one about 1.2 times as long as first, with one outer spine, and two terminal and two inner setae. *Leg 4* (Fig. 13-5). Segmentation and spinal and setal ornamentation as in leg 3 of preceding stage. Outer spine of endopodite apparently differentiated. *Leg 5* (Fig. 13-7) represented by a bare seta. In two individuals among some dissected specimens, of which the second antennular segment had a transverse suture, the fifth pair of legs for the next stage were already differentiated, and

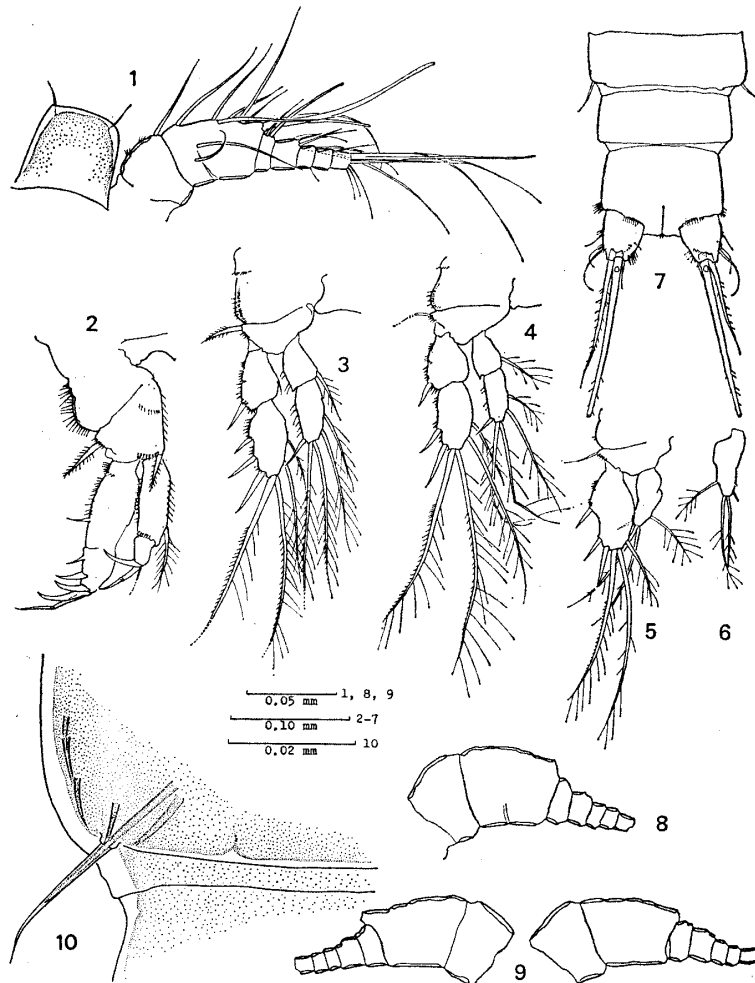


Fig. 13. *Harpacticus furcatus*. Third copepodid stage. 1-8: Female. 9-10: Male.
 1. Rostrum and antennule. 2. Leg 1. 3. Leg 2. 4. Leg 3. 5. Leg 4. 6.
 Endopodite of left leg 4. 7. Leg 5 and abdomen, ventral. 8. Antennule of
 another specimen. 9. A pair of antennules. 10. Leg 5.

these had the inner expansion of baseoendopodite, which is a characteristic of the female.

Male. Body (Fig. 10-4) somewhat narrower than female in appearance. Second antennular segment (Fig. 13-9) with no suture on its posterior side. Otherwise as in female. In the specimen illustrated, which was just before molting, the fifth pair of legs for the next stage were formed inside the fifth somite (Fig. 13-10). From its structure, the sex was determined.

4. 4. Fourth copepodid stage

Female. Body (Figs. 10-5 a, b) consisting of eight somites; sixth and seventh somites (Fig. 14-7) unornamented. Rostrum (Fig. 14-1) with two pairs of sensillae; frontal outline rounded. Antennule (Fig. 14-1). Proximal part consisting of three

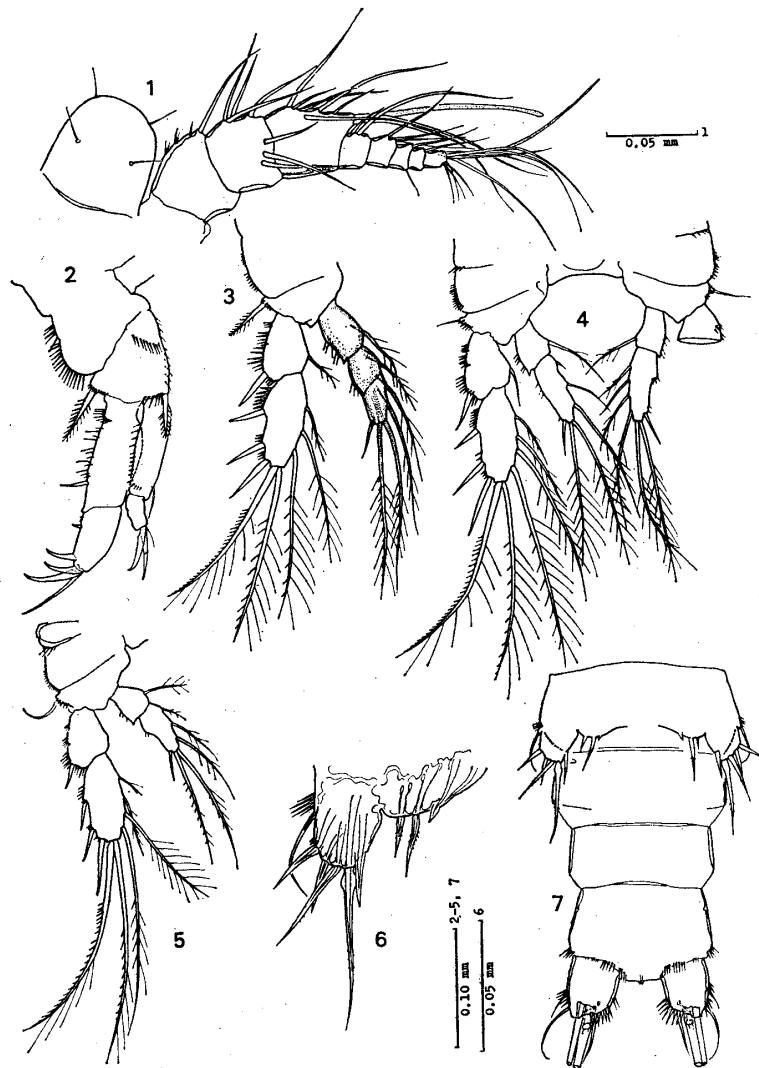


Fig. 14. *Harpacticus furcatus*. Fourth copepodid stage. Female. 1. Rostrum and antennule. 2. Leg 1. 3. Leg 2. 4. A pair of leg 3. 5. Leg 4. 6. Leg 5. 7. Leg 5 and abdomen, ventral.

segments.

Leg 1 (Fig. 14-2). Setal and spinal ornamentation as in previous stage. *Leg 2* (Fig. 14-3). Exopodite; an inner seta differentiated on first segment; an inner seta added on a point a third the length of second segment. Endopodite; a seta, which corresponds to one of the two inner setae of the middle segment in the next stage, added on a point one-fourth the length of inner margin of second segment. *Leg 3* (Fig. 14-4). Exopodite; an inner seta added onto first segment; one outer spine and two rather short inner setae added onto second one. Endopodite; two inner setae added onto second segment (setation of the right leg illustrated is abnormal). *Leg 4* (Fig. 14-5). Both rami two-segmented. Exopodite; first segment with an outer spine, but without inner seta;

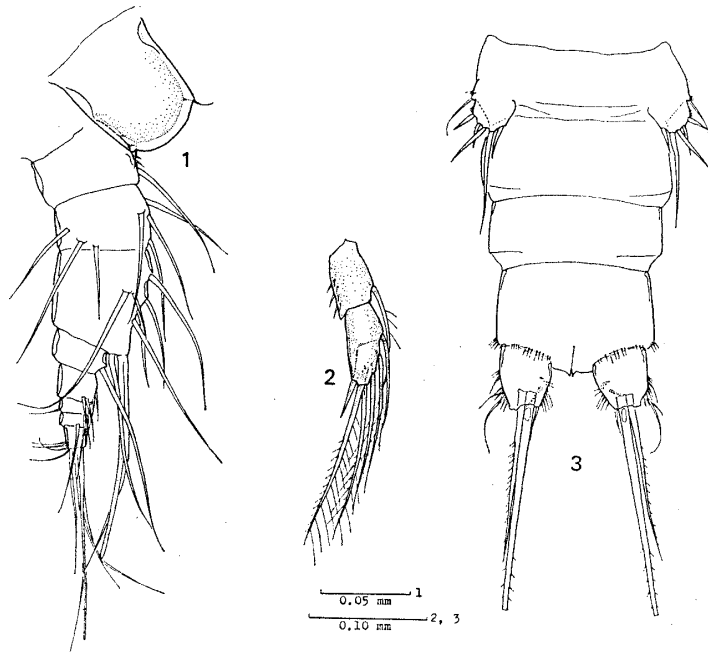


Fig. 15. *Harpacticus furcatus*. Fourth copepodid stage. Male. 1. Rostrum and antennule. 2. Endopodite of leg 2. 3. Leg 5 and abdomen, ventral.

second one about 1.5 times as long as first, furnished with three outer spines, and two terminal and four inner setae. Endopodite; first segment with an inner seta; second one about 1.3 times as long as first, of a rough outline, with one outer spine, and two terminal and three inner setae. Leg 5 (Fig. 14-6) confluent with somite; inner expansion represented by a low protuberance with three short setae, innermost one of which is not articulated at base; outer seta of baseoendopodite well differentiated. Exopodite represented by a rectangular part with four setae in all, of which terminal one is the longest and basally swollen.

Male. Body (Figs. 10-6 a, b) somewhat different from female in appearance (cf. Figs. 10-5 a and 10-6 a), 0.74 mm long. Rostrum (Fig. 15-1) with a pair of sensillae only; both lateral margins almost straight. Antennule (Fig. 15-1) consisting of eight segments, much thicker than in female.

Leg 1 ~ leg 4 ornamented as in female. In the specimen illustrated, two new segments for the next stage are already formed in the second endopodite segment of leg 2, and the spur-shaped process is clearly detected (Fig. 15-2). Leg 5 (Fig. 15-3) represented by a plate with six setae in all, of which outer proximal one corresponds to the outer seta of baseoendopodite; terminal seta longest.

4. 5. Fifth copepodid stage

Female. Body (Figs. 10-7 a, b) consisting of nine somites; sixth and eighth somites unornamented; seventh one furnished with some spinules on both lateral sides near

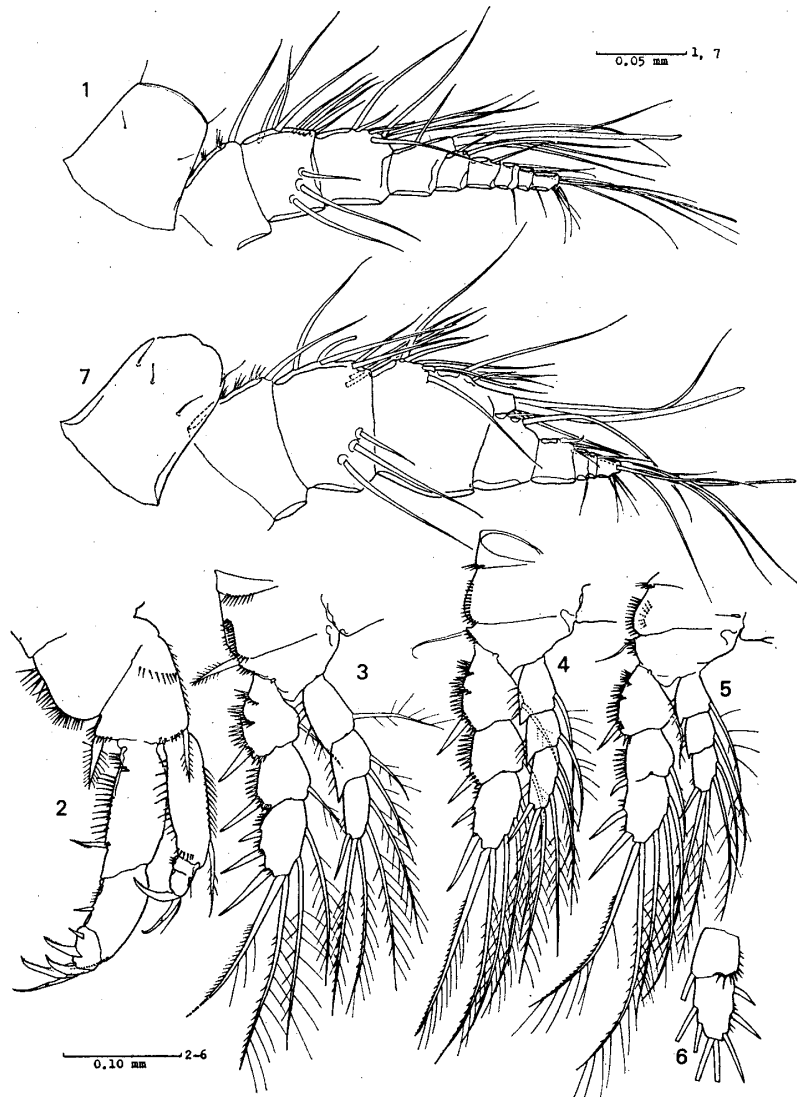


Fig. 16. *Harpacticus furcatus*. Fifth copepodid stage. 1-6: Female. 7: Male.

1. Rostrum and antennule. 2. Leg 1. 3. Leg 2. 4. Leg 3. 5. Leg 4, with an aberrant exopodite. 6. Aberrant exopodite of left leg 4.

posterior end. Rostrum (Fig. 16-1) as in adult. *Antennule* (Fig. 16-1) consisting of four-segmented proximal part and five-segmented distal part as in adult.

Leg 1 (Fig. 16-2), *leg 2* (Fig. 16-3), *leg 3* (Fig. 16-4) and *leg 4* (Fig. 16-5). Both rami of each leg three-segmented and with full spinal and setal ornamentalations. Demarcation between apical two endopodite segments of leg 1 very obscure. First two endopodite segments of leg 2, leg 3 and leg 4 sharply pointed at each outer distal corner. The exopodites of the leg 4 illustrated are abnormal (Figs. 16-5, 6). *Leg 5* (Fig. 17-1). Four setae arising from inner expansion of baseoendopodite. Exopodite still confluent with baseoendopodite, with five setae in all.

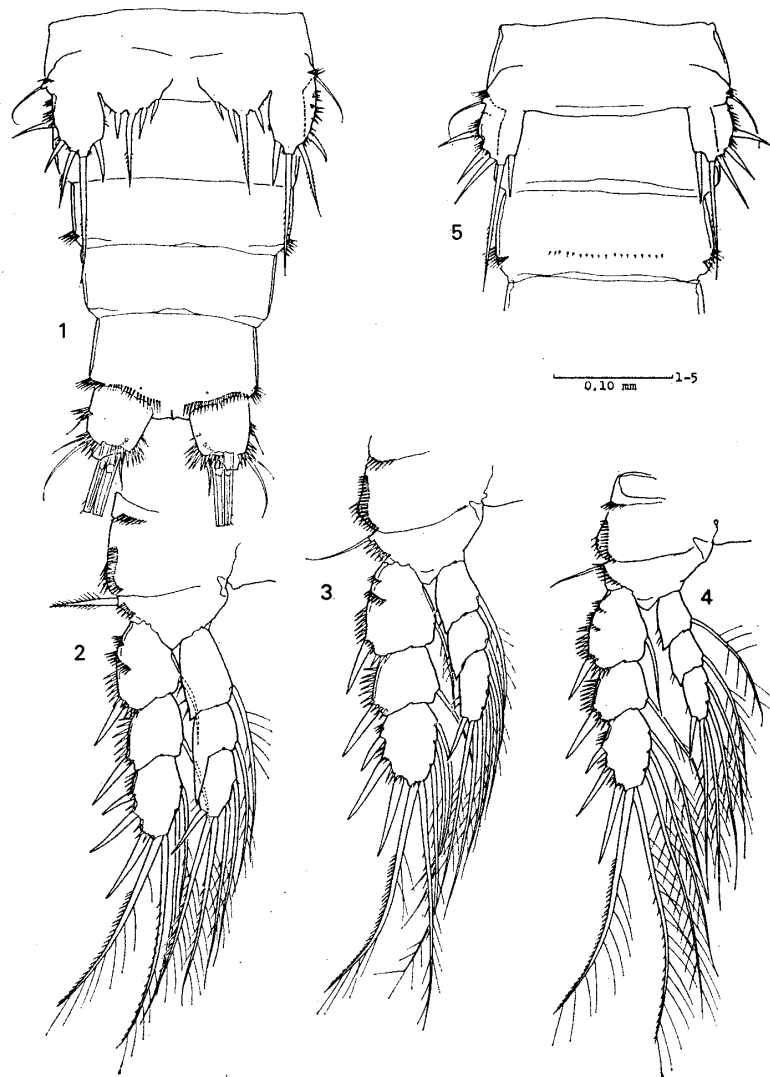


Fig. 17. *Harpacticus furcatus*. Fifth copepodid stage. 1: Female. 2-5: Male.
1. Leg 5 and abdomen, ventral. 2. Leg 2. 3. Leg 3. 4. Leg 4. 5. Leg 5 and abdomen, ventral.

Male. Body (Fig. 10-8) 0.95 mm long; sixth and eighth somites unornamented; seventh somite furnished with a transverse row of some minute spinules near hind edge of ventral side. Rostrum with two pairs of sensillae, somewhat longer than in female. The rostrum illustrated (Fig. 16-7) is abnormal in shape and situation of sensillae. *Antennule* (Fig. 16-7) very much thickened, consisting of three-segmented proximal part and five-segmented distal part.

Leg 1. Basis furnished with an oblique row of some conspicuous spinules on its anterior side as in female. *Leg 2* (Fig. 17-2), *leg 3* (Fig. 17-3) and *leg 4* (Fig. 17-4). Of last endopodite segment of leg 2, outer spine and inner terminal seta not reduced. Other spinal and setal ornamentations as in adult. Exopodite of leg 3 somewhat

thickened. Leg 5 (Fig. 17-5). Exopodite still confluent with baseoendopodite.

4. 6. Discussion

The differentiation process of each appendage through the whole copepodid stages here reported well agrees with that of *Harpacticus uniremis* KRÖYER (ITÔ, 1971), though the presence of a transverse suture on the second antennular segment in the third copepodid female is not yet recognized in the latter species as well as in the other congeneric species such as *H. gracilis* CLAUS (PUGLIESI, 1914), *H. nicaeensis* CLAUS (as *H. uniremis*; BRIAN, 1919), *H. littoralis* SARS (CASTEL, 1976) and *H. nipponicus* ITÔ (ITÔ, 1976).

The outer spine of each endopodite of leg 2, leg 3 and leg 4, on the other hand, is exactly present even in the one-segmented ramus in the present species examined. This species, therefore, is apparently of the non-retarded formation type (see ITÔ, 1976, p. 467) in the differentiation process of the outer spines in question as in *H. uniremis*. In this respect, the differentiation process in *H. littoralis* recently reported by CASTEL (1976) is quite strange, because its fifth copepodid male has a well-developed outer spine on the last endopodite segment of leg 2, though this species is more similar to those species of the retarded formation type, such as *H. gracilis* and *H. nipponicus* having only one inner seta on the middle endopodite segment of leg 2 in the female as in *H. littoralis*, than to the other species of the non-retarded formation type, such as *H. uniremis* and *H. furcatus* reported in the present paper. According to CASTEL's description and figures, moreover, his specimens of *H. littoralis* had a minute spine (une minuscule épine) on the subdistal outer edge of each endopodite of the leg 2, leg 3 and leg 4 in the first four copepodid stages, even though they were still in one-segmented condition. If each of these minute spines found in the first four copepodid stages was actually a rudiment of the outer spine, this species would be regarded as being of an intermediate condition between the non-retarded and retarded formation types so far known. On the contrary, if these minute spines in question were not rudimental outer spines but mere marginal spinules, the presence of the outer spine on the leg 2 endopodite in the fifth copepodid male becomes another problem, because the other species of the retarded formation type hitherto known have no outer spine on the corresponding endopodite segment in the male (see ITÔ, 1976). This discrepancy is an open question.

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